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A Composite Beam

Field

This invention relates to composite beams and especially to beams for construction of walls, floors, ceilings and roofing panels in particular for use in buildings.

Background of the Invention

The present invention relates to building construction and in particular to the construction of dwellings formed from spaced apart inner and outer walls in which the inner wall provides a load bearing structure which support the upper floors and roof structure etc., and the outer wall is formed of a weather resistant material e.g brickwork, timber cladding etc. A known construction of building is the Canadian timber frame house.

The present invention relates to composite beams which can be particularly, but not exclusively, used in the construction of the above buildings.

The present invention may be utilised in building panels disclosed in applicant's co-pending patent application GB-A-2391 027.

Many attempts have been made to produce composite beams which do not bend under their own weight. Composite beans are described in US Patent 4191,000 in which the top and bottom

timber flanges are connected by a plywood web. In a further development shown in US Patent 6460,310, the flanges are formed from laminated wood and include a fibre reinforcement. The flanges may be interconnected by two spaced apart webs of plywood or OSB(oriented strand board). French patent application FR-A-2691,993 again describes a composite beam having laminated wood flanges including reinforcing layers and a web comprising two spaced apart wooden or metal panels.

Statements of Invention

According to the present invention there is provided a wooden Composite beam having a central cavity surrounded by walls and filled with a core of corrugated paper or cardboard, the core being adhered to the walls surrounding the cavity.

Preferably the beam is an I beam comprising upper and lower plywood flanges interconnected by a web comprising a pair of widely spaced apart planar side walls formed from wood or wood derivative material, the cavity being formed within the web.

The flanges are made from plywood having a suitable thickness and width depending upon the size of the beam, for example a 100mm deep X 75mm wide(4" x 3"), 150mm deep X 70mm wide(6" x 2¾") or 160mm deep X 100mm wide(6.5" x 4") beam may use plywood about 6mm in thickness. Deeper beams for use with

longer spans may use thicker plywood. The 6mm ply may comprise at least three plies and preferably 5 plies.

The mutually perpendicular adjacent plies produce an extremely rigid material in directions within the plane of the wood.

The side walls may be made from hardboard, plywood, or cardboard, preferably between 2-5mm in thickness.

The core comprises a plurality of layers of corrugated paper or corrugated cardboard which are each coated in a suitable adhesive resin and laminated together. The adhesive subsequently cures or dries after assembly of the core. The corrugations may run between the flanges or substantially parallel thereto, and in the preferred arrangement the corrugations in adjacent layers are normal to each other. The corrugations in one layer may be smaller in dimensions than the corrugations in an adjacent layer.

The sidewalls are adhered to the core using a suitable adhesive resin and the assembled web including the core is adhered to the flanges also using a suitable adhesive resin. Suitable adhesive resins may be selected from any suitable liquid glue which dries or cures to a water resistant form, such glues include polymeric resins e.g. an epoxy resin, a

polyester resin, acrylate resins, water based PVA(polyvinylacetate), and two part phenolic based resins.

The width of the flanges on each side extend beyond the supporting web by about 1/3 of their total width.

Composite beams according to the present invention are structurally very rigid and don not bend under their own weight having an extremely high bending moment per unit mass. A typical 75mm X 75mm I beam weighs about 400-500 gms/metre length.

I Beams of the above type may be used in the construction of building panels having a rectangular frame having the two faces covered in board material, the frame comprising top and bottom rails, preferably formed from "U" or "H" section water resistant composite, with the two rails being joined together by a plurality of spaced apart wood composite "I" beams extending therebetween.

The term "board" includes various boards derived from timber including hardboard, cardboard,plywood, plaster board, OSB (oriented strand board.

Such a panel may form a modular load bearing panel which can be used for the construction of an inner wall, floor, ceiling or roof of a building.

When constructing an internal wall for a building, in particular a load bearing wall, adjacent wall panels are linked together by posts having side portions which are engagable within the recessed sides of the I beams. The posts are a slide fit within the recessed sides of the I beams between the flanges on the respective I-beams, as is described in GB 2391 027.

Preferably the posts are hollow having plywood sidewalls and a central cavity filled with corrugated paper or cardboard. The posts may be fixed to the panels by means of shouldered dowels secured to the web of a respective I-beam engaging in clips secured on the post, preferably within the hollow post.

Description of the Drawings

The invention will be described by way of example and with reference to the following drawings in which:

Fig.1 is an isometric view of an I beam according to the present invention,

Fig.2 is an enlarged portion of the isometric view of Fig.1,

Fig. 3 is a cross section of the I beam shown in Fig.1,

Fig. 4 is an isometric view of a second I beam also in accordance with the present Invention,

Fig. 5 is a cross-section through the beam shown in Fig.4, and

Fig. 6 is an isometric exploded view of a wall panel and including I beams according to the present invention.

Detailed Description of the Invention

Referring to Figs. 1 to 3 there is shown an I beam 10 which is a composite beam having plywood flanges 11,12 linked by a composite central web 13 so that recesses 30 are formed either side of the web 13. The overall depth D and width W of the beam 10 will be determined by the end use of the beam and material used for its construction. The present Examples shown in Figs 1-5 relate to 162mm x 100mm beam but it will be understood that other I beams, for example, 100mm X 75mm or 150mm x 70mm can be made in accordance with the invention.

The flanges 11,12 are formed from plywood having a thickness of about 6.0mm with the grain of the outer veneers extending longitudinally of the beam 10. The flanges 11,12 have awidth W of about 100 mm and have a central groove 16 on their inner surface to accommodate the web 13. The groove has a width to

suit the particular web, in this case 38mm and a depth of about 3.0mm.

The web 13 is composite structure comprising two spaced apart sidewalls 25,26 with a light weight cellular material core 17 filling the cavity therebetween. The two side walls 25,26 may be formed from one of plywood, hardboard, or card board and preferably have thickness of between 2-6mm depending upon the material chosen, in this case 3mm plywood.

The core 17 filling the cavity comprises corrugated paper or cardboard, preferably comprising a plurality of layers thereof laminated together. The corrugations may run between the flanges 11,12 or substantially parallel thereto, and in the preferred arrangement the corrugations in adjacent layers are normal to each other. In another arrangement, the corrugations in pairs of adjacent layers may be arranged so that the corrugations in one layer are smaller than the corrugations in the other layer with the corrugations extending in the same direction.

The core is made from sheets of corrugated paper which are each coated in an adhesive, preferably PVA and laminated together, the resin then being dried and cured. The core is then cut from the dried/cured resin impregnated laminate. The sidewalls 25,26 are then laminated with the core using a

suitable water resistant adhesive, which again may be PVA, to form the web. The web is then adhered to the flanges 11 & 12 also using a suitable water resistant adhesive, for example a two part phenolic resin adhesive available from Borden Chemicals, with the web being secured in the opposed grooves 16 in the flanges.

The two flanges extend beyond the web 13 on each side thereof by about 1/3 of their total width, in this example 21mm.

Composite beams according to the present invention are structurally very rigid and do not bend under their own weight. Bending tests were carried out on 150mm X 70mm beam having 5.5 mm plywood flanges 11,12, with a web 13 comprising two 4.5mm plywood sidewalls 25,26 with a 15mm corrugated paper core 17 with the corrugations extending between the flanges. The tests were carried out using the method specified in EN 408:1995E but using limited samples. The results may be summarised as follows:

Load to Failure	approx 6050 kN
Bending Strength	approx 15.7 N/mm²
Bending Stiffness	approx 3920 N/mm²

Immersion tests on composite beams according to the present invention were carried out. The results are given in Table1.

below and compared with a dry sample which is given value of 100.

Table 1.

Immersion	test		
Water 15°C	Failure	Bending	Modulus
Dry	100	100	100
1 day	86	86	135
2 day	91	91	80

A second embodiment 41 of the I beam is shown in Figs. 4 & 5. The I beam 41 is substantially similar The dowels 31 may each be attached to a support plate 32 which bears on the opposite sidewall 26. A plurality of such dowels 31 are spaced along the side wall 25 and are used for assembly of adjacent panels as will be described later.

With reference to Fig 6, there is shown a wall panel 110 which is a module for building the internal load bearing wall of a dwelling or other building. The panel 110 has predetermined standard dimensions for matching with and assembly to other modular panels, for example width W of 1200mm, thickness T of 150mm, and height H of 2400mm. Other panels according the present invention may have difference to at least some of the above dimensions.

Each panel 110 has a rectangular frame 111, having top and bottom rails 112,113 interconnected by a plurality of I Beams 41 & 10 which form the sides and vertical struts of the frame 111 and are spaced at predetermined distances apart across the width of the panel. A preferred spacing between I beams 41 & 10 is 400mm. The frame 111 is covered on one face, which is use faces externally of the building, with water resistant board 116 and its other face which in use faces inwardly of the building with a second board 117. The externally facing board 16 is preferably 8-9mm plywood or OSB and the internally facing board is a laminated board which may comprise plywood, plasterboard, fibre board, calcium board, or magnesium oxide board laminated with a layer of melamine on its exposed surface. The laminated layer may be provided with a finished decorative surface or may be suitable for painting or wall papering. The internal and external boards 17 & 16 respectively are bonded to the beams 14.

The top rail 112 comprise a "H" shaped section channel formed from water resistant wood composite, preferably 12mm plywood and the bottom rail 113 is a substantially "U" section rail. The H shaped rail 112 has open sided recesses 43 which face both inwardly and outwardly of the frame 111. The inwardly facing recess 43 received stepped end portions of the I beams 41, 10 and the outwardly facing recess receives a strip 102 used for fixing panels 110 to an upper panel during

construction. The bottom rail 113 is orientated with its recess downwards and the wall panel 110 is mounted to a floor or base by use of a sole plate 101. The sole plate 101 has a height or thickness slightly in excess of the depth of the recess 43 in the bottom rail. The recess within the bottom rail 113 of each panel can be slidably located over the sole plate 101 which has previously been secured to the floor. Nails or other fixings can then be used to secure the panel to the floor strip.

A fire test according to BS 476:20:1987 was conducted on a building panel with composite I beams according to the invention, OSB on one face and Magnesium oxide board on the other face. The OSB unexposed face remained unaffected during the test.

The beams 41 are arranged with the dowels projecting outwardly of the panels 110 and adjacent panels 110 may be linked together using a jointing post (not shown but described in detail in GB-A-2391 027. The jointing posts located within the recesses 30 on the beams 41 and engage with the dowels 31. Each dowel 31 has a groove 44 which provides an undercut shoulder which co-operates clips on the jointing post on assembly.

If desired, wall panels 10 may be placed on top of previously assembled walls up to three stories in height. A jointing strip 102 is utilised between panels. By using modules of different widths the vertical joints between the panels in one layer may be offset relative to the vertical joints in another layer.